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Application No.: 10/053,085
Office Action Dated: October 9, 2008

PATENT

In re Application of:
Raymond J. Gorte and John M. Vohs

Confirmation No.: **5527**

Application No.: **10/053,085**

Group Art Unit: **1795**

Filing Date: **November 9, 2001**

Examiner: **Wang, Eugenia**

For: **Use of Sulfur-Containing Fuels for Direct Oxidation Fuel Cells**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

DECLARATION OF DR. RAYMOND J. GORTE UNDER 37 C.F.R. § 1.132

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

I, Raymond J. Gorte, Ph.D., hereby declare the following:

1. I am a co-inventor of the above-captioned patent application ("the subject application"). My Curriculum Vitae is enclosed as **Exhibit A**. Among my credentials, I earned a Ph.D. in Chemical Engineering from the University of Minnesota, in Minneapolis, Minnesota. I am a senior technical advisor to Franklin Fuel Cells, the company seeking to commercialize the technology set forth in the above-captioned patent application..
2. I have performed research into catalysis and fuel cells relevant to the work described in this patent application as professor at the University of Pennsylvania. Franklin Fuel Cells was founded to move the research into the product phase.

3. It is my understanding that claims 2-19, 21-30., 55, 56, 58, 60, and 62-67 of the subject application are directed toward solid oxide fuel cells capable of operation with sulfur-containing hydrocarbon fuels.

4. I have reviewed the Office Action dated October 9, 2008. As I understand it, the Examiner has rejected independent claims 62-67 and those claims that depend from these claims for allegedly being obvious in light of the prior art, in particular U.S. Patents 5,445,903 (Cable) and 4,812,329 (Isenberg).

5. This declaration is made to demonstrate that fuel cells recited in claims 62-67 were not obvious at the time that the application was filed.

6. Based on my experience in the field of catalysis and fuel cells and my own observations and tests, the invention of the instant application achieves results that are unexpectedly superior to those of alternative devices in the field.

7. I understand that the Patent Office is of the view that although Isenberg discloses only operation with H₂, CO, and CH₄ as fuels, devices that result from the hypothetical combination of Cable and Isenberg references could nonetheless operate using hydrocarbon fuels having two or more carbons ("C₂⁺ hydrocarbons") and having a sulfur content of from about 1 to about 5000 ppm.

8. The Patent Office's position is mistaken. Based on my experience in the field, H₂, CO, and CH₄ behave very differently from C₂⁺ hydrocarbons when used as fuels in solid oxide fuel cells, and CH₄ would specifically behaves like CO, not like a C₂⁺ hydrocarbon.

9. Based on my experience, a nickel-based fuel cell may operate on CH₄ or H₂. Cells according to the references cited by the Patent Office, however, would form undesirable carbon deposits when run on C₂⁺ hydrocarbon fuels. Because these deposits are difficult to avoid, one of skill in the art at the time of the subject application would not have used the

devices described in either the Isenberg or Cable references in conjunction with C2+ hydrocarbon fuels.

10. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Dated: January 26, 2009

/Raymond J. Gorte, Ph.D./
Raymond J. Gorte, Ph.D.

Attachments:

Exhibit A

BIOGRAPHICAL DATA

January 2009

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Chemical & Biomolecular Engineering
University of Pennsylvania
311A Towne Building/6393
Philadelphia, PA 19104

PERSONAL

Born June 27, 1954 in Manitowoc, Wisconsin. Married.

ACADEMIC RECORD

University of Wisconsin, Manitowoc Center - August 1972 to May 1974.
University of Wisconsin, Madison - August 1974 to July 1976. BSChE awarded August 1976.
University of Minnesota - September 1976 to January 1981. PhD awarded March 1981.

TEACHING EXPERIENCE

Assistant Professor, Department of Chem Eng, University of Pennsylvania - appointed January 1, 1981.
Associate Professor, Department of Chem Eng, University of Pennsylvania - promoted July 1, 1987.
Professor, Department of Chemical Engineering, University of Pennsylvania - promoted July 1, 1993.
Chairman of Chemical Engineering - 12/13/1994 to 12/31/2000
Professor, Materials Science & Engineering (Secondary Appointment) - October 1, 2002.

HONORS

Penn Engineering Distinguished Research Award, 2001.
Russell Pearce & Elizabeth Crimian Heuer Professor of Chemical Engineering, 5/1/01 – 4/30/11.
Carl V.S. Patterson Professor of Chemical Engineering, 11/1/96 – 5/1/01.
Giuseppe Parravano Memorial Award of the Michigan Catalysis Society, 1997.
Philadelphia Catalysis Club Award, 1998.
Paul H. Emmett Award in Fundamental Catalysis of the North American Catalysis Society, 1999.
Editorial Board, Applied Catalysis A: General, April 1, 1999 – March 31, 2002.
Editorial Board, Journal of Molecular Catalysis A, July 1, 2001 –
Editorial Board, Journal of Catalysis, March 1, 2004 -
Editorial Board, Advances in Fuel Cells, January 1, 2005 -
Editorial Board, Chemical Engineering Science, July 1, 2007 -

INDUSTRIAL EXPERIENCE

Shell Development Company - June, 1977 to September, 1977.
GM Research Laboratory - June, 1979 to October, 1979

PROFESSIONAL SOCIETIES

American Institute of Chemical Engineers
American Chemical Society
American Vacuum Society
Philadelphia Catalysis Club
Electrochemical Society
American Ceramic Society

PROFESSIONAL ACTIVITIES

Program Chairman - Philadelphia Catalysis Club - 1988/89.
Director - Philadelphia Catalysis Club - 1989/90, 1994/95, 2000/01.
Chairman Elect - Philadelphia Catalysis Club - 1990/1991.
Chairman - Philadelphia Catalysis Club - 1991/92.
Past Chairman - Philadelphia Catalysis Club - 1992/1993.

Program Committee Member, International Zeolite Conference, Montreal - 1992.
 Program Chairman, International Zeolite Conference, Baltimore - 1998.
 Chair, Gordon Conference on Catalysis - 1998.
 Advisory Committee, Department of Chemical Engineering, University of Houston, 2003.

PENN ADMINISTRATIVE DUTIES

Undergraduate Curriculum Chairman - (1/1/83-6/30/83, 1/1/85-1/1/87)
 Graduate Recruiting in ChE - (11/1/86 - 5/1/91)
 Faculty Council - (7/1/92 - 5/31/93)
 Review Committee for the Department of Chemistry (1999)
 SEAS Personnel Committee (2001/2002, 2002/2003, 2003/2004, 2004/2005)
 University Graduate Council (2004 - 2008)
 Chair of Search Committee for MSE Chairman (2002).
 Chair of Search Committee for MEAM Chairman (2004).
 Chair of the CBE Graduate Group (2006 -)

PUBLICATIONS

276. "Relationship between electrical behavior and structural characteristics in Sr-doped $\text{LaNi}_{0.8}\text{Fe}_{0.2}\text{O}_{3-\delta}$ mixed oxides", T. Montini, M. Bevilacqua, E. Fonda, M. F. Casula, S. Lee, C. Tavagnacco, R.J. Gorte, and P. Fornasiero, submitted.
275. "The Water-Gas-Shift Reaction on Pd/Ceria-Praseodymia: The Effect of Redox Thermodynamics", K. Bakhmutsky, G. Zhou, S. Timothy, and R. J. Gorte, submitted.
274. "Comparison of Redox Isotherms for Vanadia Supported on Zirconia and Titania", P. R. Shah, I. Baldychev, J. M. Vohs, and R. J. Gorte, submitted.
273. "Dynamic Changes in LSM Nanoparticles on YSZ: A Model System for Non-Stationary SOFC Cathode Behavior", L. Y. Woo, R. S. Glass, R. J. Gorte, C. A. Orme, and A. J. Nelson, submitted.
272. "Nanostructured Anodes for Solid Oxide Fuel Cells", R. J. Gorte, and J. M. Vohs, submitted.
271. "Activation and Ripening of Impregnated Manganese Containing Perovskite SOFC Electrodes under Redox Cycling", G. Corre, G. Kim, M. Cassidy, J.M. Vohs, R.J. Gorte, and J.T.S. Irvine, Chemistry of Materials, accepted.
270. "An Investigation of the Structural and Catalytic Requirements for High-Performance SOFC Anodes Formed by Infiltration of LSCM", G. Kim, S. Lee, J. Y. Shin, G. Corre, J. T. S. Irvine, J. M. Vohs, and R. J. Gorte, Electrochemical & Solid State Letters, 12 (2009) B48-52.
269. "The Effect of Thermodynamic Properties of Zirconia-Supported Fe_3O_4 on Water-Gas Shift Activity", I. Baldychev, J. M. Vohs, and R. J. Gorte, Applied Catalysis A, accepted.
268. "High-Performance SOFC Cathodes Prepared by Infiltration", J. M. Vohs and R. J. Gorte, Advanced Materials, 21 (2009) 1-14.
267. "SOFC Anodes Based on Infiltration of $\text{La}_{0.5}\text{Sr}_{0.2}\text{TiO}_3$ ", S. Lee, G. Kim, J. M. Vohs, and R. J. Gorte, Journal of the Electrochemical Society, 155 (2008) B1179-83.
266. "A Thermodynamic Investigation of the Redox Properties for Ceria-Hafnia, Ceria-Terbium, and Ceria-Praseodymia Solid Solutions", G. Zhou and R. J. Gorte, Journal of Physical Chemistry B, 112 (2008) 9869-75.
265. "Redox Isotherms for Vanadia Supported on Zirconia", P. R. Shah, J. M. Vohs, and R. J. Gorte, Catalysis Letters, 125 (2008) 1-7.
264. "Efficient reduction of CO_2 in a Solid Oxide Electrolyzer", F. Bidrawn, G. Kim, G. Corre, J. T. S. Irvine, J. M. Vohs, and R. J. Gorte, Electrochemical and Solid State Letters, 11 (2008) B167-70.
263. "Enhanced Reducibility of Ceria-YSZ Composites in Solid Oxide Electrodes", G. Kim, J. M. Vohs, and R. J. Gorte, Journal of Materials Chemistry, 18 (2008) 2386-90.
262. "The Effect of Ca, Sr, and Ba Doping on the Ionic Conductivity and Cathode Performance of LaFeO_3 ", F. Bidrawn, S. Lee, J. M. Vohs, and R. J. Gorte, Journal of the Electrochemical Society, 155 (2008) B660-5.
261. "SOFC Anodes Based on LST-YSZ Composites and on $\text{Y}_{0.06}\text{Ce}_{0.94}\text{Zr}_{0.04}\text{O}_2$ ", G. Kim, M. D. Gross, W. Wang, J. M. Vohs, and R. J. Gorte, Journal of the Electrochemical Society, 155 (2008) B360-B366.

260. "A Thermodynamic Investigation of the Redox Properties of Ceria-Titania Mixed Oxides", G. Zhou, R. J. Gorte, and J. Hanson, *Applied Catalysis A*, 335 (2008) 153-158.
259. "A Comparison of the Redox Properties of Vanadia-Based Mixed Oxides", P. R. Shah, M. M. Khader, J. M. Vohs, and R. J. Gorte, *Journal of Physical Chemistry C*, 112 (2008) 2613-2617.
258. "A Study of Cerium-Manganese Mixed Oxides For Oxidation Catalysis", G. Zhou, P. R. Shah, and R. J. Gorte, *Catalysis Letters*, 120 (2008) 191-197.
257. "Analysis of the Performance of the Anode and Cathode in a Natural Gas Assisted Steam Electrolysis Cell", W. Wang, R. J. Gorte, and J. M. Vohs, *Chemical Engineering Science*, 63 (2008) 765-69.
256. "Engineering Composite Oxide SOFC Anodes for Efficient Oxidation of Methane", G. Kim, G. Corre, J. T. S. Irvine, J. M. Vohs, and R. J. Gorte, *Electrochemical & Solid State Letters*, 11 (2008) B16-19.
255. "Effect of Electrode Composition and Microstructure on Impedance-metric Nitric Oxide Sensors based on YSZ Electrolyte", L. Y. Woo, L. P. Martin, R. S. Glass, W. Wang, S. Jung, R. J. Gorte, E. P. Murray, R. F. Novak, J. H. Visser, *Journal of the Electrochemical Society*, 155 (2008) J32-J40.
254. "Hydrogen Production via CH_4 and CO Assisted Steam Electrolysis", W. Wang, J. M. Vohs, and R. J. Gorte, *Topics in Catalysis*, 46 (2007) 380-385.
253. "Preparation of SOFC Anodes by Electrodeposition", S.-W. Jung, J. M. Vohs, and R. J. Gorte, *Journal of the Electrochemical Society*, 154 (2007) B1270-75.
252. "Recent Progress in SOFC Anodes for Direct Utilization of Hydrocarbons", M. D. Gross, J. M. Vohs, and R. J. Gorte, *Journal of Materials Chemistry*, 17 (2007) 3071-77.
251. "Multilayer High Performance Ceramic Anodes", M. D. Gross, R. J. Gorte, and J. M. Vohs, *ECS Transactions* 7 (2007) 1349-54.
250. "A support layer for solid oxide fuel cells", Kipyung Ahn, Sukwon Jung, John M. Vohs, Raymond J. Gorte, *Ceramics International*, 33 (2007) 1065-70.
249. "Oxidation Enthalpies for Reduction of Ceria Surfaces", Gong Zhou, P. R. Shah, T. Montini, P. Fornasiero, and R. J. Gorte, *Surface Science*, 601 (2007) 2512-19.
248. "An examination of SOFC anode functional layers based on ceria in YSZ", M. D. Gross, J. M. Vohs, and R. J. Gorte, *Journal of the Electrochemical Society*, 154 (2007) B694-9.
247. "Probing the Effect of Local Structure on the Thermodynamic Redox Properties of V^{5+} : A Comparison of V_2O_5 and $\text{Mg}_3(\text{VO}_4)_2$ ", P. R. Shah, J. M. Vohs, and R. J. Gorte, *Journal of Physical Chemistry B*, 111 (2007) 5680-83.
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237. "Enhanced Thermal Stability of Cu-Based, SOFC Anodes by Electrodeposition of Cr", M. D. Gross, J. M. Vohs, and R. J. Gorte, *Journal of the Electrochemical Society*, 153 (2006) A1386-90.
236. "Electrodeposition of Cu into a Highly Porous Ni/YSZ Cermet", S. Jung, M. D. Gross, R. J. Gorte, and J. M. Vohs, *Journal of the Electrochemical Society*, 153 (2006) A1539-43.

235. "Comparison of Conversion and Deposit Formation of Ethanol and Butane Under SOFC Conditions", G. K. Gupta, A. M. Dean, K. Ahn, and R. J. Gorte, *Journal of Power Sources*, 158 (2006) 497-503.
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232. "Influence of Composition and Cu Impregnation Method on the Performance of Cu/CeO₂/YSZ SOFC Anodes", S. Jung, C. Lu, H. He, K. Ahn, R. J. Gorte, and J. M. Vohs, *Journal of Power Sources*, 154 (2006) 42-50.
231. "A Study of Carbon Formation and Prevention in Hydrocarbon-Fueled SOFC", T. Kim, G. Liu, M. Boaro, S.-I. Lee, J. M. Vohs, R. J. Gorte, O. H. Al-Madhi, B. O. Dabbousi, *Journal of Power Sources*, 155 (2006) 231-38.
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229. "Fabrication of SOFC Electrodes by Impregnation Methods", Y. Huang, J. M. Vohs, and R. J. Gorte, *Proceedings of the 107th American Ceramic Society Meeting*, vol. 179 (2005) 123.
228. "Novel Bimetallic Anodes for Direct Utilization of Hydrocarbon Fuels", K. Ahn, S.-I. Lee, J. M. Vohs, and R. J. Gorte, *Proceedings of the Electrochemical Society*, Vol. 2005-07, 1360-68.
227. "The Effect of Polarization on LSM-YSZ Composite Cathodes", S. McIntosh, Y. Huang, J. M. Vohs, and R. J. Gorte, *Proceedings of the Electrochemical Society*, Vol. 2005-07, 1549-54.
226. "Novel Cathodes Prepared by Impregnation Procedures", Y. Huang, J. M. Vohs, and R. J. Gorte, *Proceedings of the Electrochemical Society*, Vol. 2005-07, 1735-44.
225. "Structure and Thermal Stability of Ceria Films Supported on YSZ(100) and α -Al₂O₃(0001)", O. Costas-Nunes, R. Ferrizz, R. J. Gorte, and J. M. Vohs, *Surface Science*, 592 (2005) 8-17.
224. "Enhanced thermal stability of SOFC anodes made with CeO₂-ZrO₂ solutions", K. Ahn, H. He, J. M. Vohs, and R. J. Gorte, *Electrochemical and Solid State Letters*, 8 (2005) A414-17.
223. "Recent Developments Towards Commercialization of Solid Oxide Fuel Cells", R. J. Gorte, *AIChE Journal*, 9 (2005) 2377-81.
222. "High mobility of ceria films on zirconia at moderate temperatures", O. Costa-Nunes, R. J. Gorte, and J. M. Vohs, *Journal of Materials Chemistry*, 15 (2005) 1520 - 1522.
221. "Characterization of LSM-YSZ Composites Prepared by Impregnation Methods", Y. Huang, J. M. Vohs, and R. J. Gorte, *Journal of the Electrochemical Society*, 152 (2005) A1347-53.
220. "Studies of the Water-Gas-Shift Reaction with Ceria-Supported Precious Metals", S. Zhao and R. J. Gorte, *Catalysis Today*, 104 (2005) 18-24.
219. "Carbonaceous deposits in direct utilization hydrocarbon SOFC anode", H. He, J. M. Vohs, and R. J. Gorte, *Journal of Power Sources*, 144 (2005) 135-140.
218. "Highly Sulfur Tolerant Cu-Ceria Anodes for Solid Oxide Fuel Cells", Hongpeng He, J. M. Vohs, and R. J. Gorte, *Electrochemical and Solid State Letters*, 8 (2005) A279-280.
217. "Comparison of the Performance of Cu-CeO₂-YSZ and Ni-YSZ Composite SOFC Anodes with H₂, CO, and Syngas", O. Costas-Nunes, R. J. Gorte, and J. M. Vohs, *Journal of Power Sources*, 141 (2005) 241-249.
216. "Cu-Co Bimetallic Anodes for Direct Utilization of Methane in Solid Oxide Fuel Cells", Shung-Ik Lee, Kipyung Ahn, John M. Vohs, and Raymond J. Gorte, *Electrochemical & Solid State Letters*, 8 (2005) A48-51.
215. "Characterization of YSZ-YST Composites for SOFC Anodes", H. He, Y. Huang, J. M. Vohs, and R. J. Gorte, *Solid State Ionics*, 175 (2004) 171-176.
214. "Characterization of Cu-CeO₂ direct hydrocarbon anodes in a solid oxide fuel cell with lanthanum gallate electrolyte", S. An, C. Lu, W. L. Worrell, R. J. Gorte, and J. M. Vohs, *Solid State Ionics*, 175 (2004) 135-138.
213. "Development of Intermediate-Temperature Solid Oxide Fuel Cells for Direct Utilization of Hydrocarbon Fuels", C. Lu, S. An, W. L. Worrell, J. M. Vohs, and R. J. Gorte, *Solid State Ionics*, 175 (2004) 47-50.
212. "Recent Developments on Anodes for Direct Fuel Utilization in SOFC", R. J. Gorte, J. M. Vohs, and S. McIntosh, *Solid State Ionics*, 175 (2004) 1-6.
211. "A Comparison of Ceria and Sm-Doped Ceria for Hydrocarbon Oxidation Reactions", S. Zhao and R. J. Gorte, *Applied Catalysis A*, 227 (2004) 129-136.

210. "Direct Hydrocarbon SOFC", S. McIntosh and R. J. Gorte, *Chemical Reviews*, 104 (2004) 4845-4865.
209. "Characterization of SO₂-Poisoned Ceria-Zirconia Mixed Oxides", T. Luo and R. J. Gorte, *Applied Catalysis B*, 53 (2004) 77-85.
208. "Characterization of Sr-Doped LaCoO₃-YSZ Composites Prepared by Impregnation Methods", Y. Huang, K. Ahn, J. M. Vohs, and R. J. Gorte, *Journal of the Electrochemical Society*, 151 (2004) A1592-1597.
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206. "The Acylation of Propene by Acetic Acid over H-ZSM-5: The Role of Competitive Adsorption in Stability and Selectivity", O. Kresnawahjuesa, R. J. Gorte, and David White, *Journal of Molecular Catalysis A*, 212 (2004) 309-314.
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203. "An Examination of Carbonaceous Deposits in Direct-Utilization SOFC Anodes", S. McIntosh, H. He, S.-I. Lee, O. Costa-Nunes, V. V. Krishnan, J. M. Vohs and R. J. Gorte, *Journal of the Electrochemical Society*, 151 (2004) A604-A608.
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200. "Measurement of Electrode Overpotentials for Direct Hydrocarbon Conversion Fuel Cells", V. Krishnan, R. J. Gorte, and J. M. Vohs, *Solid State Ionics*, 166 (2004) 191-197.
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69. "Evidence for a Stable Allyl Cation Intermediate on Adsorption of Allyl Alcohol on H-ZSM-5 Zeolite", A.I. Biaglow, R.J. Gorte, and D. White, *Journal of the Chemical Society, Chemical Communications*, **1164** (1993).
68. "Characterization of Acid Sites in High-Silica H-ZSM-5, H-ZSM-12, H-Mordenite, and H-Y Using Microcalorimetry", D.J. Parrillo and R.J. Gorte, *Journal of Physical Chemistry*, **97** (1993) 8786.
67. "Orientational Order-Disorder Transition of Acetone Adsorbed at the Acid Sites of H-ZSM-5: A ¹³C NMR Study", A.I. Biaglow, R.J. Gorte, and D. White, *Journal of Physical Chemistry*, **97** (1993) 7135.
66. "Evidence for a Second CO Oxidation Mechanism on Rh/Ceria", G.S. Zafiris and R.J. Gorte, *Journal of Catalysis*, **143** (1993) 86.

65. "Adsorption Studies on Cu-ZSM-5: Characterization of the Unique Properties of Ion-Exchanged Cu", D.J. Parrillo, D. Dolence, R.J. Gorte, and R.W. McCabe, *Journal of Catalysis*, **142** (1993) 708.
64. "Characterization of H(Na)-Y Using Amine Desorption", A. Biaglow, D.J. Parrillo, and R.J. Gorte, *Journal of Catalysis*, **144** (1993) 193.
63. "Differences in the Neutralization of 2.4 to 10 keV Ne⁺ Scattered from the Cu and Au Atoms of an Alloy Surface", T.M. Buck, W.E. Wallace, R.A. Baragiola, G.H. Wheatley, J.B. Rothman, R.J. Gorte, and J.G. Tittensor, *Physical Review B*, **48** (1993) 774.
62. "CO Oxidation on Pt/ α -Al₂O₃(0001): Evidence for Structure Sensitivity", G.S. Zafiris and R.J. Gorte, *Journal of Catalysis*, **140** (1993) 418.
61. "Evidence for Low-Temperature Migration of Oxygen from Ceria to Rh", G.S. Zafiris and R.J. Gorte, *Journal of Catalysis*, **139** (1993) 561.
60. "The Formation of Stoichiometric Adsorption Complexes For Simple Thiols in H-ZSM-5 and H-ZSM-12", C. Pereira and R.J. Gorte, *Proceedings of the 9th International Zeolite Conference*, Volume 2, von Ballmoos, R., Higgins, J.B., and Treacy, M.M.J., eds., Butterworth (1993) 243.
59. "A Method for Distinguishing Bronsted-Acid Sites in Mixtures of H-ZSM-5, H-Y, and Silica-Alumina", C. Pereira and R.J. Gorte, *Applied Catalysis A*, **90** (1992) 145.
58. "Characterization of Stoichiometric Adsorption Complexes in H-ZSM-5 Using Microcalorimetry", D.J. Parrillo and R.J. Gorte, *Catalysis Letters*, **16** (1992) 17.
57. "Isopropylamine Adsorption for the Characterization of the Acid Sites in Amorphous Silica-Aluminas", J. Tittensor, R.J. Gorte, and D. Chapman, *Journal of Catalysis*, **138** (1992) 714.
56. "Characterization of Mg and Mn Substitution in AlPO-5", D.J. Parrillo, C. Pereira, G.T. Kokotailo, and R.J. Gorte, *Journal of Catalysis*, **138** (1992) 377.
55. "Characterization of CO, NO, and H₂ Adsorption on Model Pt/CeO₂ Catalysts, G.S. Zafiris and R.J. Gorte, *Surface Science*, **276** (1992) 86.
54. "The Effect of Alumina Structure on Surface Sites for Alcohol Dehydration", C. R. Narayanan, S. Srinivasan, A. K. Datye, R. Gorte, and A. Biaglow, *Journal of Catalysis*, **138** (1992) 659.
53. "A Method for Measuring the Titania Surface Area on Mixed Oxides of Titania and Silica", A.I. Biaglow, R.J. Gorte, S. Srinivasan, and A.K. Datye, *Catalysis Letters*, **12** (1992) 313.
52. "A Study of NO Adsorption on Model Pt and Rh Catalysts", G. Zafiris, S. Roberts and R.J. Gorte, *ACS Symposium Series*, **495** (1992) 73.
51. "A Study of Niobia Deposition on α -Al₂O₃(0001) and Oxidized Al", S.I. Roberts and R.J. Gorte, *Applied Surface Science*, **55** (1992) 135.
50. "Recent Advances in Understanding Zeolite Acidity", R.J. Gorte, *Trends in Physical Chemistry*, **2** (1991) 115.
49. "Adsorption of CO and NO on Rh/ZrO₂(100)", G. Zafiris and R.J. Gorte, *Journal of Catalysis*, **132** (1991) 275.
48. "An Examination of the Acid Sites in SAPO-5", A.I. Biaglow, A.T. Adamo, G.T. Kokotailo, and R.J. Gorte, *Journal of Catalysis*, **131** (1991) 252.
47. "A Study of the Acid Sites in Substituted AlPO-5", R.J. Gorte, G.T. Kokotailo, A. Biaglow, D. Parrillo, and C. Pereira, *Studies in Surface Science and Catalysis*, **69** (1991) 181.
46. "A Study of Pt Films on ZrO₂(100)", S.I. Roberts and R.J. Gorte, *Journal of Physical Chemistry*, **95** (1991) 5600.
45. "2-Propanamine Adsorption on a Fluid Cracking Catalyst", A.I. Biaglow, C. Gittleman, R.J. Gorte, and R.J. Madon, *Journal of Catalysis*, **129** (1991) 88.
44. "A Study of Acetylene Polymerization in a H-ZSM-5 Zeolite", C. Pereira, G.T. Kokotailo, and R.J. Gorte, *Journal of Physical Chemistry*, **95** (1991) 705.
43. "Amine Adsorption in H-ZSM-5", D.J. Parrillo, A.T. Adamo, G.T. Kokotailo, and R.J. Gorte, *Applied Catalysis*, **67** (1990) 107.
42. "A Comparison of Pt Overlayers on α -Al₂O₃(0001), ZnO(0001), and ZnO(0001)", S. Roberts and R.J. Gorte, *Journal of Chemical Physics*, **93** (1990) 5337.
41. "A Study of the Migration and Stability of Titania on a Model Rh Catalyst", S. Roberts and R.J. Gorte, *Journal of Catalysis*, **124** (1990) 553.
40. "Method for Determining the Lattice Concentrations of B-, Ga-, and Fe-Substituted ZSM-5", R.J. Gorte, T.J. Gricus Kofke, and G.T. Kokotailo, *ACS Symposium Series*, **437** (1990) 88.

39. "The Adsorption and Reaction of 2-Propen-1-ol in H-ZSM-5", C. Pereira, G.T. Kokotailo, R.J. Gorte, and W.E. Farneth, *Journal of Physical Chemistry*, **94** (1990) 2063.
38. "A Method for Determining Framework Concentrations of Gallium in [Ga]-ZSM-5", T.J. Grieco Kofke, G.T. Kokotailo, and R.J. Gorte, *Applied Catalysis*, **54** (1989) 177.
37. "A Photoelectron Spectroscopy Study of Pt Particles on α -Al₂O₃(0001)", E.I. Altman and R.J. Gorte, *Surface Science*, **216** (1989) 386.
36. "Stoichiometric Adsorption Complexes in H-[B]-ZSM-5 and H-[Fe]-ZSM-5", T.J. Grieco Kofke, G.T. Kokotailo, and R.J. Gorte, *Journal of Catalysis*, **116** (1989) 252.
35. "A ¹³C NMR Identification of Intermediates Formed by 2-Methyl-2-Propanol Adsorption in H-ZSM-5", M.T. Aronson, R.J. Gorte, W.E. Farneth, and D. White, *Journal of the American Chemical Society*, **111** (1989) 840.
34. "A Temperature Programmed Desorption Study of Olefin Oligomerization in H-ZSM-5", T.J. Grieco Kofke and R.J. Gorte, *Journal of Catalysis*, **115** (1989) 233.
33. "The Adsorption of NO on Small Pt Particles on α -Al₂O₃(0001)", E.I. Altman and R.J. Gorte, *Journal of Physical Chemistry*, **93** (1989) 1993.
32. "Stoichiometric Adsorption Complexes in H-ZSM-5, H-ZSM-12, and H-Mordenite", T.J. Grieco Kofke, R.J. Gorte, G.T. Kokotailo, and W.E. Farneth, *Journal of Catalysis*, **115** (1989) 265.
31. "The Characterization of Hydrocarbon Intermediates in H-ZSM-5", R.J. Gorte, T.J. Grieco Kofke, and W.E. Farneth, *Materials Research Society Conference Proceedings*, **111** (1988) 431.
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29. "The Adsorption of NO on Small Rh Particles on α -Al₂O₃(0001)", E.I. Altman and R.J. Gorte, *Journal of Catalysis*, **113** (1988) 185.
28. "The Stability of Adsorption Complexes Formed by Alcohols on H-ZSM-5", M.T. Aronson, R.J. Gorte, D. White, and W.E. Farneth, *Langmuir*, **4** (1988) 702.
27. "A Comparison of the Desorption of CO from Pt and Rh Particles on α -Al₂O₃(0001)", E.I. Altman and R.J. Gorte, *Surface Science*, **195** (1988) 392.
26. "A Study of Small Pt Particles on Amorphous Al₂O₃ and α -Al₂O₃(0001) Substrates Using TPD of CO and H₂", E.I. Altman and R.J. Gorte, *Journal of Catalysis*, **110** (1988) 191.
25. "Proton Transfer to Toluene in H-ZSM-5: TPD, IR, and NMR Studies", W.E. Farneth, D.C. Roe, T.J. Grieco Kofke, C.J. Tabak, and R.J. Gorte, *Langmuir*, **4** (1988) 152.
24. "The Characterization of Thin Platinum Films on Alumina", E.I. Altman and R.J. Gorte, *Materials Research Society Conference Proceedings*, **83** (1987) 141.
23. "Summary Abstract: The Desorption of Simple Gases From Small Pt Particles", E.I. Altman and R.J. Gorte, *The Journal of Vacuum Science and Technology A*, **5** (1987) 725.
22. "An Characterization of Thin Titania Layers Deposited on Polycrystalline Pt Using ISS and ESCA", R.J. Gorte, E.I. Altman, G.R. Corallo, M.R. Davidson, D.A. Asbury, and G.B. Hoflund, *Surface Science*, **188** (1987) 327.
21. "Methanation Kinetics Studied on a Clean and a Titania-Covered Platinum Foil", R.A. Demmin and R.J. Gorte, *Journal of Catalysis*, **105** (1987) 373.
20. "An Infrared Spectroscopy Study of Simple Alcohols Adsorbed on H-ZSM-5", M.T. Aronson, R.J. Gorte, and W.E. Farneth, *Journal of Catalysis*, **105** (1987) 455.
19. "Support Effects Studied on Model Supported Catalysts", R.A. Demmin, C.S. Ko, and R.J. Gorte, *ACS Symposium Series*, **298** (1986) 48.
18. "The Desorption of CO from Small Pt Particles Supported on Alumina", E.I. Altman and R.J. Gorte, *Surface Science*, **172** (1986) 71.
17. "The Effect of Niobia on the Methanation Activity of a Pt Foil", R.A. Demmin and R.J. Gorte, *Journal of Catalysis*, **98** (1986) 577.
16. "The Influence of Oxonium Ion and Carbenium Ion Stabilities on the Alcohol/H-ZSM-5 Interaction", M.T. Aronson, R.J. Gorte, and W.E. Farneth, *Journal of Catalysis*, **98** (1986) 434.
15. "A Comparison of Titania Overlayers on Pt, Rh, and Pd", C.S. Ko and R.J. Gorte, *Surface Science*, **161** (1985) 597.

14. "An XPS Investigation of Titania Thin Films on Polycrystalline Pt", C.M. Greenlief, J.M. White, C.S. Ko, and R.J. Gorte, *Journal of Physical Chemistry*, **89** (1985) 5025.
13. "Characterization of Oxide Impurities on Pt and Their Effect on the Adsorption of CO and H₂", C.S. Ko and R.J. Gorte, *Surface Science*, **155** (1985) 296.
12. "The Effect of Titania on the Chemisorption and Reaction Properties of Pt", R.A. Demmin, C.S. Ko, and R.J. Gorte, *Journal of Physical Chemistry* **89** (1985) 1151.
11. "The Adsorption of Isopropanol and Propylene on H-ZSM-5: Evidence for a Stable Surface Carbenium Ion", M.C. Grady and R.J. Gorte, *Journal of Physical Chemistry*, **89** (1985) 1305.
10. "Evidence for Diffusion of a Partially Oxidized Titanium Species into Bulk Pt", C. S. Ko and R. J. Gorte, *Journal of Catalysis*, **90** (1984) 59.
9. "The Adsorption of Methanol and Water on H-ZSM-5", A. Ison and R.J. Gorte, *Journal of Catalysis*, **89** (1984) 150.
8. "Design Parameters for Temperature Programmed Desorption from Packed Beds", R.A. Demmin and R.J. Gorte, *Journal of Catalysis*, **90** (1984) 32.
7. "Design Parameters for Temperature Programmed Desorption from Porous Catalysts", R.J. Gorte, *Journal of Catalysis*, **75** (1982) 164.
6. "The Coadsorption of NO and CO on Pt(111)", R.J. Gorte and L.D. Schmidt, *Surface Science*, **111** (1981) 260.
5. "Binding States and Decomposition of NO on Single Crystal Platinum", R.J. Gorte, L.D. Schmidt, and J.L. Gland, *Surface Science*, **109** (1981) 367.
4. "Nitric Oxide Adsorption on the Pt(110) Surface", R.J. Gorte and J.L. Gland, *Surface Science*, **102** (1981) 348.
3. "The Electron Energy Loss Spectrum of Isocyanic Acid on the Pt(111) Surface", R.J. Gorte, L.D. Schmidt, and B.A. Sexton, *Journal of Catalysis*, **67** (1981) 387.
2. "Temperature Programmed Desorption with Reaction", R.J. Gorte and L.D. Schmidt, *Applications of Surface Science*, **2** (1979) 381.
1. "Desorption Kinetics with Precursor Intermediates", R.J. Gorte and L.D. Schmidt, *Surface Science*, **76** (1978) 559.

BOOK REVIEWS

1. *Chemical Engineering Education* **22** (1988) 86, Review of "Catalyst Design: Progress and Perspectives" by L.L. Hegedus, A.T. Bell, N.Y. Chen, W.O. Haag, J. Wei, R. Aris, M. Boudart, B.C. Gates, and G.B. Somorjai.
2. *American Scientist*, July 1988 issue, Review of "Molecular Sieve Catalysts", by P. Michiels and O.C.E. De Herdt.
3. *Journal of the American Chemical Society*, Vol. 119 (1997) 11723, Review of Studies in Surface Science and Catalysis. Volume 102. Recent Advances and New Horizons in Zeolite Science and Technology. Edited by H. Chon, S.I. Woo, & S.-E. Park. Elsevier: Amsterdam, 1996.

PATENTS

1. "Metal Substrate Having an Insulating Barrier", R.C. Cornelison, W.B. Retallick, and R.J. Gorte, U.S. Patent # 5,288,470.
2. "Anodes for Direct Oxidation of Methane in Solid Oxide Fuel Cell", R.J. Gorte, J.M. Vohs, and R. Craciun, World Patent WO 00/52780, September 8, 2000.
3. "Method for SOFC Anode Preparation", R. J. Gorte, J. M. Vohs, and R. Craciun, Australian Patent No. 747320, August 29, 2002.
4. "Method for Solid Oxide Fuel Cell Anode Preparation", R. J. Gorte, J. M. Vohs, and R. Craciun, US Patent # 6,589,680 (2003).
5. Method for solid oxide fuel cell preparation, R.J. Gorte, J.M. Vohs, and R. Craciun, U.S. Patent 6,844,099 (2005).
6. "Direct Oxidation Method for Generating Electricity", R. J. Gorte, J. M. Vohs, and R. Craciun, US Patent #6,811,904 (2004).
7. "Method for solid oxide fuel cell preparation", R.J. Gorte, J.M. Vohs, and R. Craciun, U.S. Patent 6,939,637 (2005).

8. "Porous electrode, solid oxide fuel cell, and method of producing the same", R. J. Gorte, and J. M. Vohs, U.S. Patent 6,958,196 (2005).
9. "The Use of Sulfur-Containing Fuels for Direct Oxidation Fuel Cells", R. J. Gorte and J. M. Vohs, US Application # 20030035989.
10. "A Method for Synthesizing Direct-Oxidation Anodes for SOFCs", R. J. Gorte, J. M. Vohs, and R. Craciun, US Patent, 7,014,942 (2006).
11. "High-Performance Ceramic Anodes for Use with Strategic and Other Hydrocarbon Fuels", R. J. Gorte, J. M. Vohs, and M. D. Gross, International Patent Publication No. WO/2008/008409..
12. "Preparation of Solid Oxide Fuel Cell Electrodes by Electrodeposition", R. J. Gorte, J. M. Vohs, and M. D. Gross, US Application # 20060234855

INVITED SEMINARS

Universities

1. Iowa State University, Department of Chemical Engineering, September 26, 1985.
2. University of Pittsburgh, Department of Chemical Engineering, January 10, 1986.
3. Yale University, Department of Chemical Engineering, October 23, 1986.
4. University of Florida, Department of Chemical Engineering, September 18, 1987.
5. Princeton University, Department of Chemical Engineering, February 3, 1988.
6. Carnegie Mellon University, Department of Chemical Engineering, February 9, 1988.
7. University of Akron, Department of Chemical Engineering, March 10, 1988.
8. Rutgers University, Department of Chemical Engineering, March 10, 1989; September 27, 1990.
9. Columbia University, AT&T Materials and Molecular Chemistry Seminar, February 13, 1990.
10. University of Massachusetts, Department of Chemical Engineering, April 19, 1990.
11. State University of New York, Buffalo, Department of Chemical Engineering, November 7, 1990.
12. University of Texas, Department of Chemical Engineering, January 29, 1991.
13. Technical University of Vienna, Department of Physical Chemistry, September 16, 1991.
14. Swiss Federal Institute of Technology (ETH), Zurich, Department of Chemical Engineering, Sept 18, 1991.
15. Penn State University, Department of Chemical Engineering, October 1, 1991.
16. Louisiana State University, Department of Chemical Engineering, November 15, 1991.
17. University of New Mexico, Department of Chemical Engineering, November 26, 1991.
18. Rutgers University, Department of Physics, March 5, 1992.
19. MIT, Department of Chemical Engineering, April 3, 1992.
20. Notre Dame, Department of Chemical Engineering, September 8, 1992.
21. University of Delaware, Department of Chemical Engineering, February 11, 1993.
22. University of Pennsylvania, Department of Chemical Engineering, December 6, 1993.
23. University of Houston, Department of Chemistry, February 15, 1994.
24. University of Minnesota, Department of Chemical Engineering, May 7, 1996.
25. University of Wisconsin, Department of Chemical Engineering, October 10, 1996.
26. University of Massachusetts, Department of Chemical Engineering, February 13, 1997.
27. University of South Carolina, Department of Chemical Engineering, December 4, 1997.
28. University of Texas, Department of Chemical Engineering, September 8, 1998.
29. Penn State University, Department of Chemical Engineering, October 20, 1998.
30. University of Colorado, Department of Chemical Engineering, November 5, 1998.
31. Colorado School of Mines, Department of Chemical Engineering, November 6, 1998.
32. Lehigh University, Department of Chemical Engineering, January 27, 1999.
33. Federal University of Rio de Janeiro, Rio de Janeiro, Brazil, March 8, 1999.
34. University of Cincinnati, Department of Chemical Engineering, May 18, 2000.
35. University of Pennsylvania, Department of Chemistry, November 22, 2000.
36. Clemson University, Department of Chemical Engineering, April 19, 2001.
37. Princeton University, Department of Chemical Engineering, October 3, 2001.
38. University of Delaware, Materials Science, February 7, 2002.
39. Georgia Tech, Department of Chemical Engineering, April 17, 2002.
40. University of California, Berkeley, Department of Chemical Engineering, April 24, 2002.

41. University of Washington, Seattle, Department of Chemical Engineering, October 14, 2002.
42. Yale University, Department of Chemical Engineering (Barnett F. Dodge Lecture), March 5, 2003.
43. University of Houston, Department of Chemical Engineering, April 11, 2003.
44. Rutgers University, Department of Physics, October 16, 2003.
45. University of California, Berkeley, Department of Chemistry, February 5, 2004.
46. Stevens Institute of Technology, Chemical, Biochemical, and Materials Engineering, February 25, 2004.
47. Case Western Reserve, Department of Chemical Engineering, April 28, 2004.
48. Virginia Technical University, Department of Chemical Engineering, October 11, 2004.
49. University of Pennsylvania, Department of Chemistry, November 4, 2004.
50. Lehigh University, Department of Chemical Engineering, February 23, 2005.
51. University of Michigan, Department of Chemical Engineering, March 10, 2005.
52. University of Rochester, Department of Chemical Engineering, September 20, 2006.
53. University of Rhode Island, Department of Chemical Engineering, October 12, 2006.
54. University of Trieste, Department of Chemistry, December 7, 2006.
55. Princeton University, Mechanical Engineering, February 9, 2007.
56. University of California, Santa Barbara, Chemistry, May 2, 2007.

Industrial

1. DuPont Experimental Station, Wilmington, DE, April, 1982.
2. Mobil Research Labs, Princeton NJ, March 6, 1985.
3. GM Technical Center, Warren, MI, August 7, 1987.
4. Engelhard Corporation, Edison, NJ, July 12, 1989.
5. Union Carbide, Bound Brook, NJ, December 13, 1990.
6. ARCO Chemical Comp., Newtown Square, PA, April 23, 1991.
7. W.R. Grace, Columbia, MD, June 17, 1991.
8. Sandia National Labs, Albuquerque, NM, November 25, 1991.
9. W.R. Grace, Columbia, MD, February 13, 1992.
10. Ford Motor Company, Dearborn, MI, May 19, 1992.
11. Engelhard Corporation, Edison, NJ, August 18, 1992.
12. Alcoa, Alcoa Center, PA, September 1, 1992.
13. Nepera, Inc., Harriman, NY, September 1, 1993.
14. Ford Motor Comp., Dearborn, MI, November 4, 1993.
15. Engelhard Corporation, Edison, NJ, October 26, 1994.
16. ARCO Chemical Comp., Newtown Square, PA, August 23, 1995.
17. DuPont Experimental Station, Wilmington, DE, September 29, 1995.
18. Johnson Matthey, Wayne, PA, October, 1996.
19. Air Products, Allentown, PA, November 22, 1996.
20. General Motors, Warren, MI, March 12, 1997.
21. Allied Signal, Morristown, NJ, September 17, 1997.
22. Rohm & Haas, Springhouse, PA, August 26, 1998.
23. Petrobras, Rio de Janeiro, Brazil, March 11, 1999.
24. Ford Motor Company, Dearborn, MI, November 12, 1999.
25. DuPont Experimental Station, Wilmington, DE, April 7, 2000.
26. Honeywell, Morristown, NJ, June 27, 2000.
27. FuelCell Energy, Inc., Danbury, CT, September 21, 2000.
28. United Technologies, Hartford, CT, October 11, 2000.
29. UOP/Honeywell Invitational Lecture Series, March 13, 2001.
30. BOC, Murray Hill, NJ, April 12, 2001.
31. Shell, Houston, TX, May 16, 2001.
32. Engelhard, Edison, NJ, May 23, 2001.
33. ABB Lummus, Bloomfield, NJ, June 25, 2001.
34. United Technologies, Hartford, CT, June 29, 2001.
35. Johnson-Matthey, West Deptford, NJ, November 20, 2001.
36. United Technologies, Hartford, CT, November 28, 2001.

37. PQ Corporation, Conshohocken, PA, February 5, 2002.
38. SRI International, Menlo Park, CA, April 25, 2002.
39. United Technologies, Hartford, CT, August 29, 2002.
40. Siemens Westinghouse, Pittsburgh, PA July 21, 2004
41. Engelhard, Edison, NJ, September 21, 2005.
42. Exxon-Mobil, Clinton, NJ, March 27, 2008.
43. Air Products, Allentown, PA, April 24, 2008.

Meetings

1. "Design Parameters for TPD from Packed Beds", presented at the 13th North American Thermal Analysis Society Conference, Philadelphia, PA, September, 1984.
2. "The Characterization of Niobia and Titania Overlayers on Clean Metal Surfaces", presented at the Symposium on the Catalytic Chemistry of Niobium Compounds, Pittsburgh, PA, September 11, 1986.
3. "Proton Transfer Adsorption in H-ZSM-5", presented at the Middle Atlantic Regional Meeting of the ACS, Stockton State College, NJ, May 19, 1987.
4. "Desorption of Simple Gases from Small Pt Particles", presented at the French-US Seminar on Catalysis, Evanston, IL, July 7, 1987.
5. "A Study of the Acid Sites in High Silica Zeolites", 2nd Korea/USA Catalysis Workshop, Dearborn, MI, May 13, 1989.
6. "Support Effects Studied on Model Supported Catalysts", presented at the DOE Basic Energy Sciences Meeting, Washington, D.C., March 26, 1990.
7. "Support Effects Studied on Model Supported Catalysts", presented at the New England Catalyst Society, April 19, 1990.
8. "Characterization of Zeolite Acidity by Thermal Analysis", presented at the Thermal Analysis Forum of the Delaware Valley, June 6, 1990.
9. "A Study of the Acid Sites in High Silica Zeolites", First Brazil/USA Catalysis Workshop, Rio de Janeiro, Brazil, October 15-17, 1990.
10. "A Study of Acidity in H-ZSM-5", Materials Research Society Annual Meeting, Boston, MA, December 3, 1991.
11. "A Study of the Acid Sites in Zeolites", Indo-American Workshop on Zeolite Heterogeneous Catalysis, Dehra Dun, India, January 4-10, 1992.
12. "A Study of Zeolite Acidity Using Temperature Programmed Desorption", American Chemical Society Meeting, Symposium on Catalyst Characterization, Washington, DC, August 1992.
13. "Methods for Characterizing the Acidity of Supported Oxides", DOE Basic Energy Sciences Meeting, Santa Monica, CA, March 11, 1992.
14. "Particle Size and Support Effects on Model Catalysts", Gordon Conference on Catalysis, June 28- July 3, 1992.
15. "Characterization of Acid Sites and Hydrocarbon Intermediates in Molecular Sieves", New York Catalysis Club, September 23, 1992
16. "Characterization of Acid Sites and Hydrocarbon Intermediates in Molecular Sieves", Chicago Catalysis Club, October 12, 1992.
17. "Studies of Acidity in Molecular Sieves", Meeting of the Lehigh Valley AIChE, February 15, 1993.
18. "Uses of Microcalorimetry and Thermal Analysis For the Characterization of Molecular Sieves", Meeting of the Thermal Analysis Society, March 17, 1993.
19. "Acidity of Solid Acids: Definition and Measurement", Gordon Conference on Catalysis, June 26 - July 1, 1994.
20. "Definitions of Acidity in Solid Acids", Philadelphia Catalysis Club, Spring Symposium, May 10, 1995.
21. "Ceria-Based Anodes for the Direct Oxidation of Methane in Solid-Oxide Fuel Cells", Philadelphia Catalysis Club, Spring Symposium, May 16, 1996 (with E. S. Putna).
22. "Transport of Oxygen from Ceria to Supported Metals", DOE Basic Energy Sciences Meeting, Houston Texas, May 22, 1996.
23. "Calorimetric Techniques for the Characterization of Zeolite Acidity", Workshop on Calorimetric Techniques, Mayaguez, Puerto Rico, July 7 and 8, 1996.

24. "Methods for Characterization of Zeolite Acidity", Exxon Symposium on Acid/Base Catalysis, Houston, TX, September 24-26, 1996.
25. "Ceria Structure Sensitivity for Oxygen Storage Properties", Michigan Catalysis Society, Dearborn, MI, March 11, 1997.
26. "Characterization of Zeolite Acidity", Michigan Catalysis Society, Dearborn, MI, May 13, 1997.
27. "Characterization of Zeolite Acidity", New Jersey ACS, Trenton, NJ, February 10, 1998.
28. "Methyl Rotors in the Adsorption of Acetonitrile in H-MFI: A Method for Examining Confinement at the Acid Sites", Symposium to honor J. Fripiat, ACS Regional Meeting in Milwaukee, WI, June 2, 1998.
29. "Characterization of Zeolite Acidity", IZA Preconference Summer School, Bryn Mawr, PA, July 1998.
30. "Model Studies for Understanding Oxygen Storage Capacity in Three-Way Automotive Catalysis", Philadelphia Catalysis Club, September 17, 1998.
31. "Model Studies for Understanding Oxygen Storage Capacity in Three-Way Automotive Catalysis", Tri-State Catalysis Club, Lexington, KY, April 20 and 21, 1999.
32. "Attempts to Describe the Important Factors in Zeolite Catalysis", Philadelphia Catalysis Club Spring Symposium, April 28, 1999.
33. Emmett Award Lecture, North American Catalysis Society Meeting, Boston, MA, May 1999.
34. "What do we need to know about solid acids to use them in chemical synthesis?", Workshop on Catalysis, Santa Fe, Argentina, September 2-4, 1999.
35. "Direct Oxidation of Dry Hydrocarbons in a SOFC", ONR Grand Challenge Workshop, Alexandria, VA, November 16, 1999.
36. "Direct Oxidation of Dry Hydrocarbons in a SOFC", DARPA Workshop, Arlington, VA, March 30, 2000.
37. "Studies of Cooperative Effects in Ceria-Supported Metals for WGS and Other Reforming Reactions", ARO Workshop on Fuel Processing, Detroit, June 19, 2000.
38. Testified for Congressional Subcommittee on Energy and the Environment, Ursinus College, Collegeville, PA, June 26, 2000.
39. "Calorimetric Measurements at Low Temperatures for Characterization of Adsorption", Second International Conference on Calorimetry and Thermal Effects in Catalysis, Lyon, France, July 5-7, 2000.
40. "Direct-Oxidation Fuel Cells", Tau Beta Pi Meeting, Philadelphia, PA, February 10, 2001.
41. "Direct-Oxidation Fuel Cells", ONR Contractors Meeting, Annapolis, MD, February 19, 2001.
42. "The Need for More Catalyst Research", DOE Workshop, Oakland, CA, February 28, 2001.
43. "Direct-Oxidation Fuel Cells", Chicago Catalysis Society, March 13, 2001.
44. "Direct-Oxidation Fuel Cells", Invited talk, American Ceramic Society, Indianapolis, IN, April 23-25, 2001.
45. "Direct-Oxidation Fuel Cells", Philadelphia Catalysis Society, May 31, 2001.
46. "Developing Fuel Cells that Run on Real Fuels", CatCon2001, Houston, TX, May 14-15, 2001.
47. "Direct-Oxidation Fuel Cells", Southwest Catalysis Society, College Station, TX, May 18, 2001.
48. "Direct-Oxidation Fuel Cells", Keynote Speech, 17th Meeting of the North American Catalysis Society, Toronto, Ontario, June 3-8, 2001.
49. "Developing Fuel Cells that Run on Real Fuels", DOE Small Fuel Cell Workshop, Washington, DC, June 14, 2001.
50. "Direct-Oxidation Fuel Cells", Gordon Conference on Fuel Cells, July 30-August 4, 2001.
51. "Developing Fuel Cells that Run on Real Fuels", Keynote Speech, National ACS Meeting, Chicago, IL, August 27-31, 2001.
52. "Anodes for the Direct Oxidation of Hydrocarbons in SOFCs", Invited Talk, Grove International Fuel Cell Conference, London, September 11-13, 2001.
53. "Developing Fuel Cells that Run on Real Fuels", South Jersey ACS Meeting, November 20, 2001.
54. "Development of robust solid-oxide fuel cells", American Physical Society, Indianapolis, IN, March, 2002.
55. "Direct-Oxidation Fuel Cells", Invited talk, Society of Automotive Engineers, Detroit, MI, March 2002.
56. "Anode Development for Direct Oxidation of Hydrocarbons", Electrochemical Society Meeting, Philadelphia, PA, May 12-17, 2002.
57. "Fuel Cell Technology, Present and Future", Tulane Engineering Forum, New Orleans, LA, September 13, 2002.
58. "The Surface Chemistry of Solid-Oxide Fuel Cells", Keynote Speech, American Vacuum Society, Denver, CO, November 4, 2002.
59. "Developing Fuel Cells that Operate on Real Fuels", U Penn Provost Seminar, November 19, 2002.

60. "Direct-Oxidation SOFCs", ESF-NSF Workshop on Anodes for High-Temperature Fuel Cells, Strasbourg, France, December, 2002.
61. "Recent Developments on Anodes for Direct Fuel Utilization in SOFC", DOE-BES Workshop on Hydrogen, May 13-15, 2003.
62. "Recent Developments on Anodes for Direct Fuel Utilization in SOFC", Plenary speaker, 14th International Solid State Ionics Meeting, Monterey, CA, June 22-27, 2003.
63. "Recent Developments on Anodes for Direct Fuel Utilization in SOFC", Senior Catalysis Researcher Lecture Series at the Pacific Northwest National Laboratory, July 16, 2003.
64. "Fuel Cells", part of Science 101 Series, offered to Congressional Staff, by the Science Coalition, July 21, 2003, Washington, DC.
65. "Studies of Ceria-Supported Metals for WGS and Other Applications", Catalysis Symposium, Oak Ridge National Laboratory, October 23, 2003.
66. "Advances in Fuel Cells", LRSM's Lecture Series for Science Teachers, Philadelphia, PA, November 6, 2003.
67. "Fueling Fuel Cells: The Fuel Story", University of Pennsylvania Provost's Lecture Series, November 19, 2003.
68. "Recent Developments on Anodes for Direct Fuel Utilization in SOFC", Philadelphia Section of the Society of Automotive Engineers, November 20, 2003.
69. "Solid Oxide Fuel Cells", Gordon Conference on Catalysis, June 27, 2004.
70. "Catalytic Issues in SOFC", Dutch-US Workshop, August 19, 2004.
71. "Ceria-based catalysts: From automotive applications to the water-gas shift reaction", in the session on Nanotechnology in Catalysis, ACS 228th National Meeting, Philadelphia, PA, August 22, 2004.
72. "Recent Developments Towards Commercialization of Solid Oxide Fuel Cells", invited lecture in "Fundamentals" session at the AIChE Annual Meeting, Austin, TX, November, 2004.
73. "An SOFC Tutorial", invited lecture in "Tutorials" session at the AIChE Meeting, Austin, TX, November, 2004.
74. "SOFC for Man-Portable Power", at the Meeting for Emerging Fuel Cell Technology with Global Implications, Washington, DC, January 12, 2005.
75. "Fabrication of SOFC Electrodes by Impregnation Methods", in the International Symposium on Fuel Cells and Related Systems in the *107th Annual Meeting & Exposition of the American Ceramic Society*, Baltimore, Md, April 10, 2005.
76. "Perovskite Composites for SOFC Cathodes", at the National ACS Meeting, Washington, DC, August 28, 2005.
77. "Direct Oxidation SOFC", New York Catalysis Society, September 21, 2005.
78. "Fabrication of SOFC Electrodes by Impregnation Methods", Canadian Fuel Cell Systems Symposium, Banff, Alberta, October 14, 2005.
79. "SOFC Electrodes", at the Fourth Eastern Mediterranean Conference on Chemical Engineering (EMCC-4), January 6, 2006, Israel.
80. "Bimetallic Anodes for SOFC", American Ceramic Society, Cocoa Beach, FL, January 22, 2006.
81. "Ceria Catalysis: From OSC to WGS", Philadelphia Catalysis Club, February 16, 2006.
82. "Recent developments on SOFC for use with hydrocarbon fuels", Manitoba Society of Automotive Engineers Meeting, Winnipeg, March 23, 2006.
83. "A Thermodynamic Investigation of the Redox Properties of Ceria-Zirconia Solid Solutions", ACS Symposium Honoring J. Dumesic, Atlanta, GA, March 28, 2006.
84. "Recent developments on SOFC for use with hydrocarbon fuels", 2006 Haldor-Topsoe Catalysis Forum, August 24, 25, 2006, Copenhagen.
85. "Infiltrated Cathodes", 7th Annual DOE-SECA Workshop, September 13, 2006, Philadelphia, PA.
86. "Catalysts for the Hydrogen Economy", AVS 53rd International Symposium, November 14, 2006, San Francisco, CA.
87. "SOFC", Conference on Synthesis and Methodologies in Inorganic Chemistry, December 3, 2006, Brixen, Italy.
88. "SOFC and SOE", International Symposium of Materials Issues in the Hydrogen Economy", Richmond, VA, November 12-15, 2007.
89. SOFC, 5th Eastern Mediterranean Chemical Engineering Conference, May 24, 2008, Centrarò, Italy.

COURSES TAUGHT

ChE 200(230)	Material and Energy Balances
ChE 350	Fluid Mechanics
ChE 351 (MEAM 333)	Heat Transfer
ChE 353	Advanced Chemical Engineering Science
ChE 410	Chemical Engineering Laboratory
ChE 451	Chemical Reactor Design
ChE 460	Process Control
ChE 501(ENM 511)	Engineering Mathematics II
ChE 521	Special Topics in Heterogeneous Catalysis
ChE 621	Reactor Design
ChE 700	Topics in Catalysis
MSE 321	Electronic Materials

MSE GRADUATE STUDENTS DIRECTED

A. Ison	The Coadsorption of Water and Methanol on H-ZSM-5, 1983.
M. C. Grady	Adsorption of 2-Propanol and Propene on H-ZSM-5: Evidence for a Stable Surface Carbenium Ion, 1984.
G. J. Seaven	Design and Construction of an Auger Electron Spectrometer Within a Reactor System, 1987.
C. Pereira	A Spectroscopic Study of Allyl Alcohol Adsorption in H-ZSM-5: Characterization of Allylic Intermediates, 1989.
J. Tittensor	Isopropylamine Adsorption on Silica-Alumina Catalysts, 1991.
J. Garcia	Characterization of Model Silica-Alumina Catalysts, 1992.
K. Trafford	Modeling Adsorption in Siliceous Zeolites, 2000.

PhD GRADUATE STUDENTS DIRECTED

C. S. Ko	The Effect of Oxides on the Adsorption of CO and H ₂ on Pt, Rh, and Pd, 1985.
R. A. Demmin	Methanation Studies on Model Supported Catalysts, 1986.
M. T. Aronson	A Spectroscopic Study of Simple Alcohols Adsorbed on H-ZSM-5 Zeolite, 1987.
E. I. Altman	Adsorption of Simple Gases on Model Supported Catalysts, 1988.
T. J. Gricus Kotke	Adsorption Studies of the Acid Sites in High-Silica Zeolites, 1989.
S.I. Roberts	Studies of Support Effects on Model Catalysts, 1991.
C. Pereira	A Study of Acidity, Adsorption, and Reaction in High-Silica Zeolites and Aluminophosphate Molecular Sieves, 1992.
G.I. Zafiris	Support and Metal Particle Size Effects on Platinum and Rhodium Model Catalysts, 1993.
A.I. Biaglow	NMR and TPD Studies of Zeolite Acidity, 1993.
D.J. Parrillo	High Temperature Microcalorimetry of High Silica Zeolites, 1994.
H. Cordatos	A Study of Support Effects on Lanthana- and Ceria-Supported, Noble Metals, 1996.
T. Bunluesin	A Study of Support-Metal Interactions on Ceria- and Ceria/Zirconia-Supported Metals, 1997.
C.-C. Lee	Characterization of Acidity in Molecular Sieves, 1997.
E. S. Putna	Characterization of Oxygen-Storage Components for Three-Way Catalysts, 1998.
J. Šepa	Interactions of Probe Molecules with Zeolites: Effect on Structure and Localization as Determined from NMR Spectroscopy, 1998.
S. Savitz	Low-Temperature Calorimetry for the Characterization of Zeolites, 1999.
F. Siperstein	Thermodynamic Excess Functions for Mixture Adsorption on Zeolites, 2000.
O. Kresnawahjuesa	Investigation of Adsorption Complexes Formed in Acylation Reactions on Zeolites, 2003.
C. Lu (MSE)	Characterization of Cu-SDC Anodes for Direct Utilization of Dry Hydrocarbons, 2004.
S. McIntosh	Development of Direct Hydrocarbon Solid Oxide Fuel Cells, 2004.
T. Luo	A Study of SO ₂ Poisoning on Ceria Based Three-Way Catalysts, 2004.
S. Zhao	A Study of the Catalytic Properties of Ceria-Based Materials in the WGS Reaction and Hydrocarbon Oxidations, 2005.
O. Costa-Nunes	Direct Oxidation SOFC: Aspects of Anode Performance Optimization, 2005.

Y. Huang	Novel Cathodes for SOFCs Prepared by Impregnation Procedures, 2006.
M. D. Gross	Improved SOFC Anodes for Direct Utilization of Hydrocarbons, 2007.
S.-W. Jung	Novel Fabrication Methods for SOFC Anodes, 2007
G. Zhou	Characterization of the Equilibrium Redox Properties For Ceria-Based Mixed Oxides, 2008.
P. Shah	Thermodynamic Properties of Mixed Oxides, 2008.

POSTDOCTORAL FELLOWS

A.I. Biaglow	1993 - 1994
R. Craciun	1997 - 1998
S. Park	1998 - 2001
S. Hilaire	1999 - 2000
L. Yang	1999 - 2000
Hyuk Kim	2000 - 2001
Xiang Wang	2000 - 2002
Marta Boaro	2001 - 2003
Venkat Krishnan	2001 - 2003
Robert Ferrizz	2001 - 2002
Shengli An	2002 - 2003
Hongpeng He	2002 - 2005
Shung-Ik Lee	2002 - 2004
Kipyung Ahn	2003 - 2005
Gang Liu	2003 - 2004
Taeyoon Kim	2004 - 2006
Wensheng Wang	2005 - 2007
Leta Woo	2006 - 2008
Guntae Kim	2007 - 2009
Shiwoo Lee	2007 -
Noah Wieder	2009 -

Current Graduate Students

<u>Student</u>	<u>Anticipated Grad Date</u>	<u>Degree Sought</u>
I. Baldychev	December 2009	PhD
F. Bidrawn	December 2009	PhD
K. Bakhmutsky	December 2011	PhD
R. Kungas	December 2012	PhD